Quantum superluminal communication does not result in the causal loop

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We show that the quantum superluminal communication based on the quantum nonlocal influence, if exists, will not result in the causal loop, this conclusion is essentially determined by the peculiarity of the quantum nonlocal influence itself, according to which there must exist a preferred Lorentz frame for consistently describing the quantum nonlocal process.

As we say quantum mechanics permits no superluminal communication [3], we should refer to the present quantum theory, and realize that the concrete reason is not related to the peculiarity of the quantum nonlocal influence, which is manifested in Bell's theorem [2] and has been confirmed by more and more experiments [4], on the contrary, this kind of quantum nonlocal influence may help to achieve the superluminal communication when transcending the present quantum theory.

But, on the other hand, people may naturally argue that even regardless of the limitation from present quantum theory, special relativity will also inhibit such superluminal communication based on the quantum nonlocal influence owing to the causal loop, thus superluminal communication is definitely hopeless. However, people look down on the peculiar quantum nonlocal influence, in fact, it not only is independent of the limitation of present quantum theory on superluminal communication, but also rejects special relativity to some extent [5], here we will demonstrate that the description about quantum nonlocal influence needs a preferred Lorentz frame, and the quantum superluminal communication based on such quantum nonlocal influence, if exists, does not result in the causal loop, this undoubtedly opens the first door to superluminal communication.

At first, Hardy's theorem [5] first states that any dynamical theory describing the quantum nonlocal process, in which the predictions of the theory agree with those of ordinary quantum theory, must have a preferred Lorentz frame, and the description about the quantum nonlocal influence is no longer independent of the selection of inertial frame, this evidently breaks the first assumption of special relativity, which asserts that the description of any physical process is independent of the selection of inertial frame. But in Hardy's proof he presupposed that the collapse process happens simultaneously in all observing inertial frames or there is no backward causality in quantum systems, which validity is still not clear, this weakens the strength of his conclusion.

Then, Percival extended Hardy's theorem, he gave a different derivation based on classical links between two Bell experiments in different experimental inertial frames [8–10], which is called the double Bell experiment, and his proof is independent of any assumptions about causality in the quantum domain, thus it is just the quantum nonlocal influence itself that requires the dynamical theory about it must have a preferred Lorentz frame, or there will exist the forbidden causal loops in the systems with classical inputs and outputs.

On the other hand, Suarez's analysis about multisimultaneity [6,7] has also indicated that the description about the causal orders of the nonlocal correlating events essentially needs a preferred Lorentz frame, although he didn't realize this fact himself, in fact, his elegant one Bell experiment involving 2-after impacts will also generate the forbidden logical causal loop if we assume that no preferred Lorentz frame exists, or the quantum nonlocal influence happens simultaneously in all experimental frames, since as to these two space-like classical events in the experiment, each is the cause of the other, and this is evidently a logical contradiction. Thus Suarez's one Bell experiment also demonstrates that there must exist a preferred Lorentz frame in order to consistently describe the quantum nonlocal process.

Now, all the above demonstrations have clearly indicated that the consistent description about the quantum nonlocal influence needs a preferred Lorentz frame, in which all quantum nonlocal influences are simultaneous, and the causal relation between the correlating quantum nonlocal events are exclusively determined, then all quantum nonlocal influences will be no longer simultaneous in other inertial frames according to Lorentz transformations, in fact, in these frames, the quantum nonlocal influence, or quantum simultaneous communication if exists, will proceed forward in time along one direction in space, and proceed backward in time along the contrary direction in space, the causal relations between these correlating quantum nonlocal events in these frames will no longer relate directly to their time orders, and be only determined by their time orders in the preferred Lorentz frame, then it is evident that there will no longer exist any causal loops for the quantum nonlocal influence and possible quantum simultaneous communication based on such quantum nonlocal influence, since the causal relations of the correlating quantum nonlocal events are exclusively determined by their time orders in the preferred Lorentz frame, and causes always come before effects.

At last, I will give a simpler apagogical demonstration, namely if the quantum simultaneous communication based

on the quantum nonlocal influence leads to the forbidden causal loops, then the quantum nonlocal influence itself will also lead to the forbidden causal loops, the reason is simple, since in Percival's double Bell experiment [8–10], if we devise the experimental settings in order that the quantum simultaneous communication based on the quantum nonlocal influence leads to the forbidden causal loops with certainty, then the quantum nonlocal influence itself will also lead to the forbidden causal loops with a nonzero probability, as Percival has minutely demonstrated [8–10], this is not permitted either, thus we again get the conclusion, namely quantum superluminal communication, if exists, does not result in the causal loop.

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